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THE CAUSES OF FIRES ON NORTHEASTERN NATIONAL FORESTS

WILLIAM A. MAIN AND DONALD A. HAINES

NORTH CENTRAL FOREST EXPERIMENT STATION
FOREST SERVICE
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WILLIAM A. MAIN is a Computer Programmer and DONALD A. HAINES is a Principal Research Meteorologist. They are headquartered at the Station's office in East Lansing, Michigan, which is maintained in cooperation with Michigan State University.

North Central Forest Experiment Station
John H. Ohman, Director
Forest Service - U.S. Department of Agriculture
Folwell Avenue
St. Paul, Minnesota 55101
(Maintained in cooperation with the University of Minnesota)
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THE CAUSES OF FIRES ON NORTHEASTERN NATIONAL FORESTS

William A. Main and Donald A. Haines

In the interest of contributing more basic information for fire prevention, the USDA Forest Service issued new fire reporting instructions in 1960. Personnel were to record four revised factors on the fire report form (USDA Forest Service 1960):

1. The person who started the fire was categorized into one of eight groups.
2. The activity[1] in which the person was engaged was categorized into one of eight groups.
3. The land-use cause of the fire was categorized into one of 40 items.
4. The specific cause of the fire was categorized into one of 41 items.

All categories within the above groups were not mutually exclusive. The first group in particular was a problem. Some of the entries could be placed in two or more of the categories because the categories are not rigidly delineated.

The purpose of the present study was to cross-tabulate the above categories of people, activities, land-use causes, and specific causes to find the combination of these categories most responsible for forest fires in the northeastern national forests (fig. 1). Prevention efforts could then be directed toward these groups.

THE DATA BASE

Before cross-tabulating, we examined the sets of people, their activities, and the 2 sets of fire causes for entry and coding errors and then tabulated the 1960-69 data for the 15 national forest protection areas in the northeastern United States. Although the original data were for individual protection areas, we will usually look at the region as a whole in order to determine what groups are causing fires. We must consider forest users not only as individuals, but *en masse* as well, if we are to be successful in influencing the behavior of groups (Herrman 1964).

From 1960 through 1969, the national forests in the northeast recorded 8,486 wildfires and 77,040 burned acres. The following tabulation of the eight activity categories shows the percent of wildfires in each.

Activity[2]	*Percent of total fires*
Incendiarism	23
Land use[3]	22
Tobacco smoking	19
Recreation[4]	18
Equipment usage	7
Lightning[5]	4
Forest usage	1
Miscellaneous[6]	6
Total	100

The top four activities, incendiarism, land use, tobacco smoking, and recreation, are nearly equal in importance as far as number of fires are concerned. The other four activities are lesser problems.

Almost half of the fires, 4,101, were started by local permanent residents who live inside or adjacent to the forest protection boundaries. This agrees with other studies of major fire starters (Banks and Holt 1966, Christiansen and Folkman 1971). Classes of fire starters are shown below by order of importance.

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[1] *Lightning was considered an activity.*

[2] *This category is labeled "statistical cause" in the USDA Forest Service (1960) handbook.*

[3] *Includes fires resulting from refuse burning, land clearing, railroad right-of-way burning, spontaneous combustion, etc.*

[4] *Includes all fires resulting from recreation activity except smoking.*

[5] *Lightning is the only major fire-cause activity not initiated by people. In many western areas of the United States it is the primary cause of wildfire.*

[6] *Includes fires resulting from insect control, smoking bees, glass not set by an incendiarist, destruction of stills by law officers, etc.*

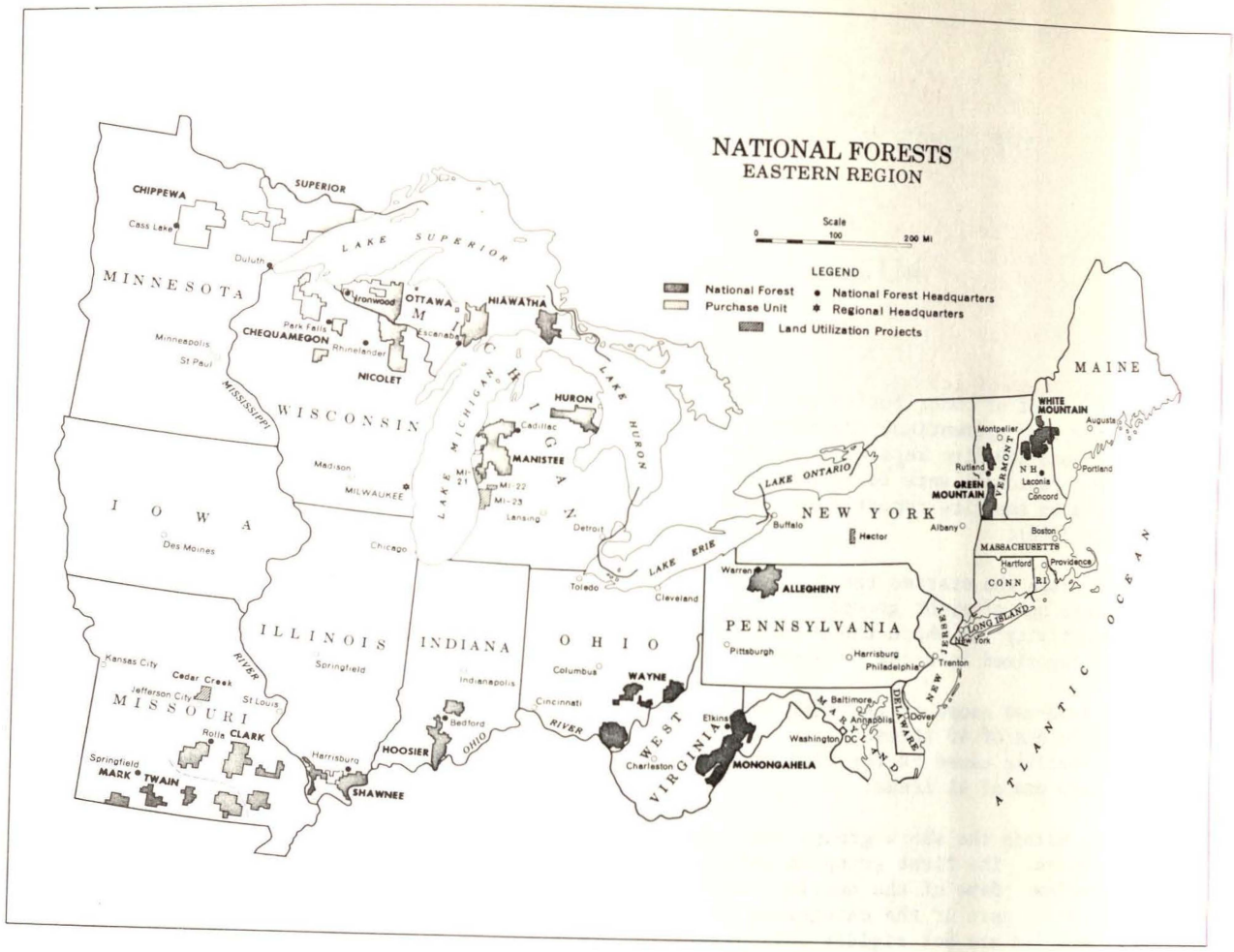

Figure 1.--*National forests in northeastern United States. The Wayne-Hoosier and the Huron-Manistee are combined protection units.*

Class of people	*Percent of total fires*
Local permanent residents	48
Transients, tourists, or other through-travelers	12
Private landowners and businessmen	11
Seasonal workers or visitors	5
Permittees	2
Contractors	1
Public employees	1
Other	20
Total	100

HOW RELIABLE ARE THE DATA?

Even though the individual fire reports of the Forest Service are supposed to be completed uniformly throughout the country, flaws in the reporting form and certain tendencies of those filing the report introduce inaccuracies.

The fire report forms do not have an "unknown" category in the activity block so that the fire investigator is sometimes forced to guess the activity that resulted in the wildfire. Also, the form provides no space for the investigator to state his confidence in the entries.

In other studies the accuracy of entries assigning fires to smokers was found to be less than entries assigning fires to incendiarists. Both were considerably less accurate than entries of lightning fires, campfires, debris-burning fires, and railroad fires. The poor entry record for smoker-caused fires results from a tendency to report unknown fires as smoker-caused (Chandler 1960, Banks and Holt 1966). Inaccuracies also occur in the percent of fires started by locals because investigators tend to report fire starters of unknown residency as nonlocals (Chandler 1960).

Thus, in the following discussion we should keep in mind that the percent of fires assigned to smoking and incendiarism may be somewhat high. Fire start percents assigned to locals are probably low.

CROSS-TABULATING THE DATA

The category percents listed under activity and class of people are already commonly used in operational planning. The problem, however, is that these categories present unclear pictures. For example, the first tabulation shows that 18 percent of the fires are caused by recreational activity. But do locals, transients, or seasonals cause the greatest number of fires while recreating? We attempted to answer this type of question by making cross-tabulations of the various categories of people, activity, land-use causes, and specific causes, producing a list of combinations.

A computer program cross-tabulated the 4 categories, based on number of fires, and generated more than 200 different combinations with 3 or more fires in each. Thirty-five combinations had data with 50 or more fires; 31 meaningful combinations were ranked by the number of fires they represented regionwide (table 1). The leading combinations on the individual protection units of the national forests were listed in table 2.

Local residents involved in incendiarism, specifically pyromania, were by far the leading combination with 907, or 11 percent, of the region's fires (table 1). Pyromania, however, is an unfortunate classification term as it implies that the investigator has made a medical judgment. Incendiarism by local residents for reasons other than pyromania was the third ranked combination. Incendiarism for whatever reason is especially high in the forests of southern Missouri and Indiana. There, as in many southeastern States, fire activity most often results from social, not psychological, causes. This activity is strongly affected by the attitudes and habits of the people; some residents accept woods burning as a normal practice. The high incidence of local incendiarism is largely from four of the region's national forests: the Clark, Mark Twain, Wayne-Hoosier, and the Chippewa (table 2). These forests also account for 59 percent of all the fires in the region.

Interestingly, local hunters and fishermen cause more fires, not by letting cooking fires escape or smoking tobacco products, but rather by hunters attempting to smoke-out game. This is the second leading combination in the region (table 1). The overwhelming number of these fires occur on the two Missouri forests, the Clark and Mark Twain, an area where many residents observe this practice. This situation

Table 1.--*Leading combinations on the national forests in the northeastern region (1960-69) ranked by number of fires*

Class of people	Activity	General land-use cause	Specific cause	Number of fires	Rank
Local	Incendiarism	Incendiary	Pyromania	907	1
Local	Recreation	Hunting and fishing	Smoking game	453	2
Local	Incendiarism	Incendiary	Other things	427	3
Local	Land use	Resident	Refuse burning	413	4
Other	Lightning	Lightning	Lightning	329	5
Owner	Equipment usage	Railroad	Exhaust	255	6
Local	Incendiarism	Incendiary	Grudge fire	251	7
Local	Smoking	Hunting and fishing	Smoking	251	8
Owner	Land use	Resident	Refuse burning	212	9
Transient	Smoking	Hunting and fishing	Smoking	148	10
Transient	Smoking	Highway	Smoking	140	11
Local	Smoking	Smoking	Smoking	125	12
Other	Smoking	Hunting and fishing	Smoking	108	13
Transient	Recreation	Recreation	Cooking fire	103	14
Transient	Smoking	Recreation	Smoking	96	15
Transient	Recreation	Hunting and fishing	Cooking fire	89	16
Transient	Recreation	Hunting and fishing	Smoking game	86	17
Local	Land use	Agriculture	Land clearing	83	18
Seasonal	Smoking	Hunting and fishing	Smoking	82	19
Local	Miscellaneous	Resident	Matches	81	20
Local	Smoking	Recreation	Smoking	78	21
Local	Recreation	Hunting and fishing	Warming fire	75	22
Other	Recreation	Hunting and fishing	Smoking game	67	23
Local	Land use	Resident	Other things	64	24
Local	Smoking	Highway	Smoking	61	25
Local	Land use	Other occupancy	Refuse burning	60	26
Transient	Smoking	Other smoking	Smoking	58	27
Local	Land use	Agriculture	Meadow burning	55	28
Local	Land use	Resident	Land clearing	51	29
Owner	Land use	Agriculture	Land clearing	51	30
Local	Miscellaneous	Miscellaneous	Matches	51	31

Table 2.--*Leading combinations on individual protection units of the national forests (1960-69) ranked by number of fires*

National forest	Class of people	Activity	General land-use cause	Specific cause	Number of fires
Allegheny					
103 total fires	Owner	Equipment use	Railroad	Exhaust emission	7
645 burned acres	Transient	Smoking	Hunt and fish	Smoking	6
489,400 acres protected[1]	Transient	Smoking	Recreation	Smoking	5
Chequamegon					
105 total fires	Other	Lightning	Lightning	Lightning	7
450 burned acres	Seasonal	Smoking	Hunt and fish	Smoking	7
863,600 acres protected	Transient	Smoking	Hunt and fish	Smoking	4
	Other	Smoking	Highway	Smoking	4
Chippewa					
387 total fires	Local	Incendiarism	Incendiary	Other things	31
4,042 burned acres	Local	Land use	Resident	Refuse burning	23
1,246,500 acres protected	Transient	Smoking	Hunt and fish	Smoking	18
	Local	Smoking	Hunt and fish	Smoking	16
Clark					
2,127 total fires	Local	Incendiarism	Incendiary	Pyromania	398
26,767 burned acres	Local	Recreation	Hunt and fish	Smoking game	324
1,537,100 acres protected	Local	Incendiarism	Incendiary	Other things	143
	Local	Land occupancy	Resident	Refuse burning	141
	Local	Incendiarism	Incendiary	Grudge fire	125
	Local	Smoking	Hunt and fish	Smoking	100
	Owner	Land occupancy	Resident	Refuse burning	67
	Other	Lightning	Lightning	Lightning	52
Green Mountain					
65 total fires	Other	Lightning	Lightning	Lightning	8
141 burned acres	Other	Land occupancy	Other occupation	Refuse burning	3
379,000 acres protected					
Hiawatha					
292 total fires	Owner	Equipment use	Railroad	Exhaust emission	53
1,235 burned acres	Other	Lightning	Lightning	Lightning	24
1,189,100 acres protected	Local	Misc. activity	Resident	Matches	10
Huron-Manistee					
1,202 total fires	Owner	Land occupancy	Resident	Refuse burning	87
6,519 burned acres	Local	Land occupancy	Resident	Refuse burning	47
1,750,600 acres protected	Transient	Smoking	Recreation	Smoking	38
	Seasonal	Land occupancy	Resident	Refuse burning	34
Mark Twain					
1,397 total fires	Local	Incendiarism	Incendiary	Pyromania	314
15,573 burned acres	Local	Incendiarism	Incendiary	Other things	118
1,005,700 acres protected	Local	Recreation	Hunt and fish	Smoking game	88
	Local	Land occupancy	Agriculture	Land clearing	57
	Local	Incendiarism	Incendiary	Grudge fire	51

[1]1969 total protected acreage.

Continued on next page

points up the difficulty of trying to overcome local customs in the name of fire prevention.

The refuse-burning fire by local residents is a major problem on northeastern national forests just as it is in the southern region of the country, and was ranked fourth among combinations (table 1).

Even though lightning fires stand apart from these combinations of people-caused fires, they were ranked along with the others for comparison. As the fifth highest combination cause, lightning is not solely a problem of western forests (table 1). It is the main combination cause on five forests; the Chequamegon, Green Mountain, Monongahela, White Mountain, and Superior (table 2). On the Hiawatha it is second only to locomotive exhaust fires. Lightning is of special concern on the Superior because it started 106 fires, almost one third of the regional lightning-fire total.

The combinations ranked sixth, seventh, and eighth were each responsible for about 250 fires (table 1). Railroad exhaust equipment was the primary or secondary cause of fires on five national forests (table 2). A significant number of fires, 48, were caused by fuel sparks from railroad engines. Other unlisted railroad fires were the result of miscellaneous railroad

Table 2 continued

National forest	Class of people	Activity	General land-use cause	Specific cause	Number of fires
Monongahela					
224 total fires	Other	Lightning	Lightning	Lightning	22
1,792 burned acres	Owner	Equipment use	Railroad	Exhaust emission	19
1,191,400 acres protected	Seasonal	Smoking	Hunt and fish	Smoking	12
	Local	Incendiarism	Incendiary	Grudge fire	11
Nicolet					
233 total fires	Transient	Smoking	Hunt and fish	Smoking	15
1,475 burned acres	Transient	Smoking	Other smoking	Smoking	8
941,700 acres protected	Local	Smoking	Other smoking	Smoking	8
Ottawa					
164 total fires	Owner	Equipment use	Railroad	Exhaust emission	42
631 burned acres	Other	Lightning	Lightning	Lightning	15
1,223,400 acres protected	Local	Smoking	Hunt and fish	Smoking	7
Shawnee					
406 total fires	Owner	Equipment use	Railroad	Exhaust emission	28
5,237 burned acres	Local	Land occupancy	Resident	Refuse burning	21
490,600 acres protected	Other	Smoking	Hunt and fish	Smoking	15
	Transient	Smoking	Highway	Smoking	15
Superior					
604 total fires	Others	Lightning	Lightning	Lightning	106
2,999 burned acres	Transient	Recreation	Recreation	Cook fire	81
2,722,000 acres protected	Transient	Recreation	Hunt and fish	Cook fire	72
	Transient	Smoking	Hunt and fish	Smoking	22
Wayne-Hoosier					
1,108 total fires	Local	Incendiarism	Incendiary	Pyromania	170
9,278 burned acres	Local	Land occupancy	Resident	Refuse burning	109
532,400 acres protected	Local	Incendiarism	Incendiary	Other things	96
	Local	Smoking	Hunt and fish	Smoking	49
White Mountain					
69 total fires	Other	Lightning	Lightning	Lightning	21
131 burned acres	Transient	Recreation	Recreation	Cook fire	6
788,100 acres protected	Transient	Smoking	Recreation	Smoking	5
	Other	Smoking	Recreation	Smoking	4

equipment (23), brakeshoes (12), and improper use of fusees (8). Grudge fires by local incendiarists ranked seventh while fires from local hunters and fishermen smoking tobacco were next (table 1).

An examination of the 4 categories that make up the leading 35 combinations showed that in the class of people category local residents were involved in 17 of the 35 combinations. Also, local residents or owners caused the fires in 9 of the first 10 combinations (table 1). Hunters and fishermen (from the general land use cause category), whether local, transient, or seasonal, are a leading cause of fires, primarily because of smoking-out game and smoking tobacco. Although fire percents from tobacco smoking may be somewhat high as cautioned earlier, hunters and fishermen were the starters in 4 of the leading combinations involving smoking and these caused a total of 589 fires. Other types of recreationists do not appear to be nearly as much of a fire risk as the hunter-fisherman. Campers, picnickers, and other similar recreationists were responsible for well under 300 fires of all kinds. Hunters and fishermen, on the other hand, were responsible for 9 of the leading combinations for a total of well over 1,300 fires (table 1).

Permittees, contractors, and public employees were not found to be major fire starters in the region; none of them appear within the first 60 combinations.

Some of the important cause combinations on the individual forests (table 2) are not significant regionally, and vice-versa. Varying land ownership and use patterns on individual forests have a tremendous influence on the cause of fire.

TABULATION BASED ON COST-PLUS-LOSS EVALUATION

A justifiable argument is often made that an examination of numbers of fires alone does not present the complete wildfire story. Forest fires have varying suppression costs, burned acreage, and most important, value losses. We attempted to integrate these factors using the cost-plus-loss formula currently used by the national forests in their fire planning procedures.

Cost-plus-loss (CL) evaluation is as follows: for fires 1/4 acre or less, CL = 1 unit; for fires more than 1/4 acre to 1/2 acre, CL = 5 units; for fires 1/2 acre to 9 acres, CL = 5 units + (V x A) where:

V = Land value loss. Land was divided into seven classes depending on the type of vegetation and use of the area. Land value losses range from 30 units per acre for class 1 down to 2.5 units per acre for class 7.

A = Burned acreage.

For fires 10 acres or larger, CL = (S x A) + (V x A) where:

V = as above,

A = as above, and

S = suppression cost estimated as 1 unit per acre.

For example, a 50-acre fire on class 3 land (a value loss (V) of 10 units per acre) results in: CL = (S x A) + (V x A), so CL = (1 x 50) + (10 x 50) = 550 units; i.e., 50 units of suppression cost plus 500 units of land value loss result in 550 units of CL.

After machine computation, the leading 30 cost-loss combinations were ranked (table 3). Generally, the ranking of the combinations in tables 1 and 3 is very similar, although there are some important differences.

With the exception of lightning fires, the leading 10 combinations of table 1 are still within the top 10 in table 3, although their order is changed. Refuse-burning fires have increased in significance and are, consequently, of special interest. The two combinations of these fires advanced from fourth and ninth places in table 1 to second and seventh. The importance of this type of fire apparently cannot be judged solely by numbers.

The class of people category is still highly dominated by locals, but two permittee combinations are now among the leaders. Timbering and electrical power transmission were far down the list of general land-use causes when ranking was based on number of fires.

CONCLUSIONS

An analysis of 10 years of data on 15 northeastern national forest protection units shows that fire cause is a diversified problem across the region. Nevertheless, local people most often start fires, no matter what the activity. The local incendiarist is still the most pressing prevention riddle, even though fire-start figures listed under this activity may be somewhat high. Incendiarism is not only the largest northeastern problem in fire prevention, but also the most difficult to solve aside

Table 3.--*Leading combinations on the national forests in the northeastern region (1960-69) ranked by cost-loss units*

Class of people	Activity	General land-use cause	Specific cause	Cost-loss units[1]	Rank
Local	Incendiarism	Incendiary	Pyromania	1,048	1
Local	Land use	Resident	Refuse burning	881	2
Local	Incendiarism	Incendiary	Other things	836	3
Local	Smoking	Hunting and fishing	Smoking	723	4
Local	Incendiarism	Incendiary	Grudge fire	717	5
Owner	Equipment usage	Railroad	Exhaust	453	6
Owner	Land use	Resident	Refuse burning	407	7
Local	Recreation	Hunting and fishing	Smoking game	320	8
Owner	Land use	Agriculture	Land clearing	308	9
Transient	Smoking	Hunting and fishing	Smoking	272	10
Other	Incendiarism	Incendiary	Grudge fire	234	11
Local	Smoking	Smoking	Smoking	216	12
Other	Lightning	Lightning	Lightning	181	13
Other	Land use	Industry	Mill waste	134	14
Other	Smoking	Hunting and fishing	Smoking	131	15
Local	Land use	Agriculture	Land clearing	131	16
Permittee	Land use	Electric power	Powerline	129	17
Local	Recreation	Hunting and fishing	Warming fire	123	18
Local	Smoking	Timbering	Smoking	98	19
Local	Land use	Agriculture	Meadow burn	92	20
Local	Equipment usage	Timbering	Exhaust	91	21
Permittee	Smoking	Timbering	Smoking	87	22
Transient	Incendiarism	Incendiary	Grudge fire	82	23
Local	Land use	Agriculture	Range burn	81	24
Local	Incendiarism	Incendiary	Job fire	79	25
Owner	Equipment usage	Railroad	Fuel sparks	79	26
Local	Smoking	Recreation	Smoking	79	27
Local	Miscellaneous	Resident	Matches	66	28
Seasonal	Recreation	Hunting and fishing	Smoking game	65	29
Transient	Smoking	Highway	Smoking	61	30

[1]In ten thousands of units (10^4).

from the lightning fire. True incendiary fires are not the result of lack of knowledge or even of carelessness, but are, of course, deliberately started, and the individuals responsible have low group identification.

One source of confusion in dealing with this problem results from mixed application of the term incendiarist. Not all people so labeled are psychopaths. Many incendiarists act from traditional, social attitudes. Dramatic successes in fire prevention have resulted by reaching this latter group through community action programs.

Success in preventing fires might be expected by reaching visible groups such as debris burners or equipment operators. Unlike true incendiarists, these people do not attempt to keep their operations secret. Unfortunately, they are not a cohesive group because they have little in common except that most use such things as refuse burners. A group approach, although not as formidable as with true incendiarists, is still difficult.

Railroaders, hunters, and fishermen are all highly visible, relatively cohesive groups that can be more easily reached using traditional prevention techniques. Strong, partly successful efforts in fire prevention are already being used with railroaders in areas of the northeast. In some cases results are achieved after dealing directly with engineers and brakemen. At other times contact with higher level management personnel is necessary.

Because hunters and fishermen become a "reachable" group through licensing, and are more of a fire problem than all other recreationists combined, stronger prevention efforts could be directed toward them. California has done an exhaustive study on hunter attitudes toward--and knowledge of--wildfire and its prevention (Herrman 1962, Davis and Chandler 1962, Folkman 1963). Some of these findings may also apply to the northeast.

A number of prevention approaches could be used with the hunter-fisherman group. Many are proud of being called sportsman; consequently, an appeal to that pride may be effective. Some belong to local rod and gun clubs; these are obvious platforms for fire prevention appeals. Conversely, much of the hunting and fishing, especially that done on northeastern forests with high fire incidence, is the traditional, way-of-life variety rather than in a modern image of *Outdoor Life* or *Field and Stream*. We suspect that there may be a tremendous overlap of those hunters who smoke-out game and leave smoldering warming fires with those incendiarists who set fires to increase grazing land or "green up" the woods. As already pointed out, those incendiarists sometimes may be reached through community action programs.

Most importantly, hunters and fishermen are licensed; information on fire prevention can be passed out during licensing formalities. Finally, infraction of fire laws by this group might be met with the same punishments as game violations. In many States this involves not only fines but also loss of license, fishing tackle, and firearms. With an identifiable group many approaches are possible. Hunters and fishermen account for nine of the primary combinations in fire starts; therefore, concentration on them should be productive.

Forest fire prevention programs must continue to reach the general public with all methods, in all forms. But regional emphasis could be placed upon identifiable classes of people who we can easily contact and with whom there is some leverage. This study indicates that hunters and fishermen are the most obvious group.

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Sing along with Woodsy and help stop pollution.